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2021

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Accelerated Dry Aging under Anaerobic Conditions

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Summary with Implications

The purpose of dry aging is to develop novel flavors and other sensory characteristics different from wet aged meat. However, leaving meat exposed to air for an extended period of time can have negative effects on meat quality. As the meat is exposed to oxygen for an extended period of time, lipids are oxidized resulting in compounds that negatively affect flavor. In this study, oxygen concentration was regulated along with time, temperature, humidity, and air flow. The purpose of oxygen regulation was to determine the effect of oxidation on the quality, specifically flavor preference, of dry aged meats. Sensory analysis via untrained panelists detected no flavor differences between traditionally dry aged meat and meat dry aged in anaerobic conditions, despite anaerobic dry aged samples having lower lipid oxidation values. Further sensory analysis via highly trained panelists is being conducted to determine if lipid oxidation affects dry aged beef flavor.

Introduction

Dry aged beef is marketed as having improved flavor, although the causes of dry aged flavor are still not fully understood. Additionally, while the flavor of dry aged beef may be more intense, whether or not it is improved relies solely on the preferences of the consumer. The two likely causes of “dry aged flavor” are: 1) the concentration

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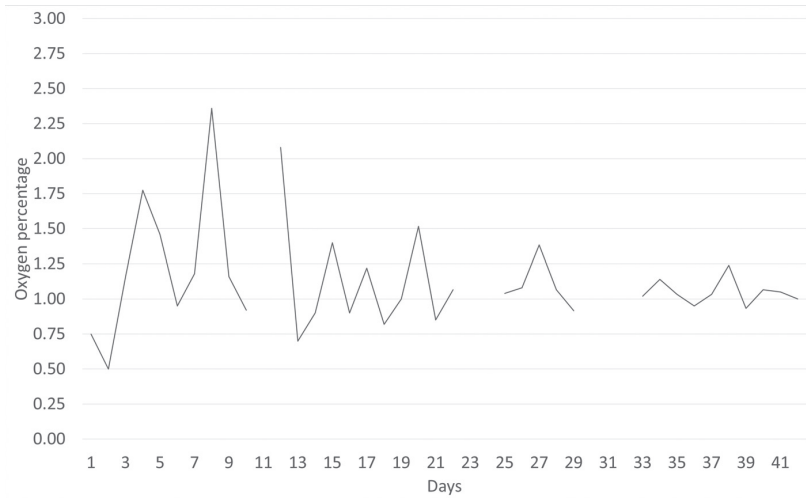


Figure 1. Average oxygen percentage in anaerobic dry aging chambers over time.

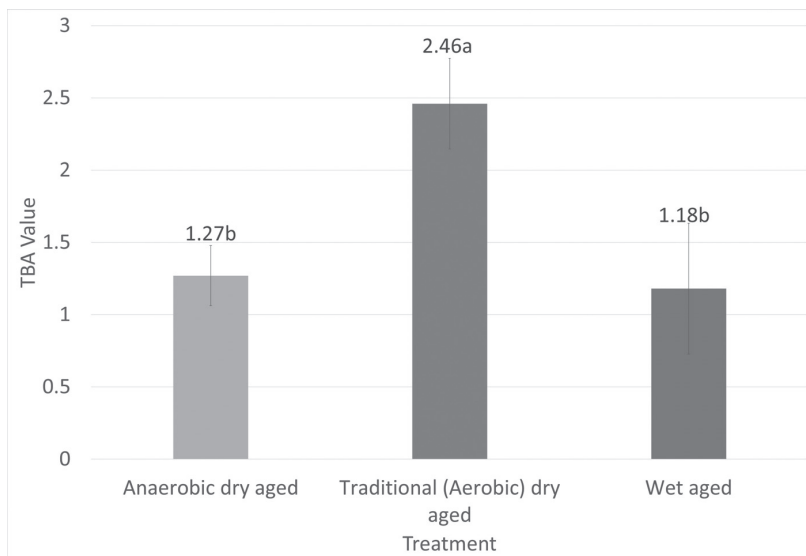


Figure 2. Lipid oxidation measurements via thiobarbituric acid reactive substances (TBARS) of anaerobic dry aged, traditional (aerobic) dry aged, and wet aged loins.

of flavor compounds as the meat loses moisture, and 2) the development of new flavors via enzymatic and oxidative processes.

Lipid oxidation is a natural process that

occurs when meat is exposed to oxygen.

The oxidation of lipids results in secondary reactive products that negatively affect meat flavor. The objective of this research was to determine the effects of lipid oxidation on

Table 1. Moisture loss, trim loss, final weight and final yield of wet and dry aged loins.

Trait	Dry Aging Treatment			SEM ^c
	Anaerobic	Traditional (Aerobic)	Wet	
Moisture loss during aging (lbs.)	3.48 ^a	3.35 ^a	0 ^b	0.17
Trim loss (lbs.)	3.02 ^a	3.04 ^a	0.71 ^b	0.12
Total weight loss (lbs.)	6.53 ^a	6.42 ^a	0.71 ^b	0.29
Final weight (lbs.)	7.96 ^a	7.50 ^a	13.38 ^b	0.30
Final yield (%)	55% ^a	54% ^a	95% ^b	0.04

^{a,b} Means in the same column with different superscripts are different ($P < .05$)

^c Standard error of the means.

Table 2. The number of panelists preferring anaerobic or traditional (aerobic) dry aged loins by day of sensory test.

Preference	Sensory day		Total
	Day 1	Day 2	
Anaerobic dry aged	12 ^a	19 ^a	31 ^a
Traditional (Aerobic) dry aged	14 ^a	10 ^a	24 ^a

^a Means in the same column with different superscripts are different ($P < .05$)

the flavor of dry aged beef. The hypothesis of this project was that dry aging meat in anaerobic conditions would inhibit lipid oxidation, resulting in the absence of the negative flavor compounds associated with lipid oxidation and ultimately a superior dry aged product.

Procedure

Eighteen USDA upper 2/3 Choice boneless strip loins were assigned to one of three treatments: wet aging, traditional (aerobic) dry aging, or anaerobic dry aging. All strip loins were aged for 41 days, not including aging at the processing facility. The dry aged samples were held at 50% relative humidity (RH) with a fan speed of 2,200 revolutions per minute (RPM) and a constant temperature (37°F). The wet aged samples were retained in the original vacuum sealed packages from the processor and were held in the same cooler as the dry aged samples. After aging, the dry aged loins were trimmed of all dehydrated lean and fat, fabricated into steaks, evaluated for trim loss and final weight, and separated for further analyses. Further analyses included sensory analysis, and lipid oxidation via the thiobarbituric acid reactive substances (TBARS) assay.

The aerobic dry aged loins were aged

in aging chambers exposed to normal atmospheric conditions (ca. 21% oxygen). A computer system regulated relative humidity at 50% and monitored weight loss during the aging period. Anaerobic dry aged loins were aged in aging chambers that were enclosed in oxygen impermeable film. Tubing connecting the chambers to the various components of the system was also oxygen impermeable. The various components of the system include an air pump to circulate the air in the system, silica gel filled columns to control relative humidity, and an oxygen scavenger column in which food grade oxygen scavengers were regularly replaced to help keep the oxygen concentration low. The system was not able to reach true anaerobic conditions, but the oxygen concentration was kept below 1.5% with a few minor peaks during the 41-day aging period. Oxygen concentration during aging is presented in Figure 1. Several gaps in the data can be noted in the graph; this was due to a computer error where the system continued to run but failed to report the data. No spikes in oxygen concentration occurred at those times. The anaerobic systems were flushed with a gas mixture consisting of 80% nitrogen (N) and 20% carbon dioxide (CO₂) at the start of aging and again if the oxygen concentration approached 4%. Relative humidity was

controlled by the system, whereas weight loss and oxygen concentration were only monitored.

A paired preference test was conducted to determine consumer flavor preference between anaerobic and traditionally (aerobic) dry aged steaks. Panelists were served two samples and asked to identify the sample whose flavor they most preferred. The first day compared the first three loins of each dry age treatment and the second day compared the last three loins. Sensory steaks were cooked to medium well (158°F) and then cut to a sample size of 2 cm × 1 cm × 2.54 cm. Each sample was given a random, unique 3-digit number and served to 25–30 panelists. Panelists received no training prior to the analysis.

Lipid oxidation (TBARS) was measured to compare differences in the level of lipid oxidation based on aging method. Measurements reflect the amount of thiobarbituric acid reactive substances in the lean portion of the sample. External fat was removed prior to TBARS analysis.

Standard tables were used to determine the significance of the paired preference test. All other data were analyzed as a randomized complete block.

Results

Wet aged loins, as expected, had lower weight loss during aging, less trim loss, and overall higher yield as shown in Table 1. There were no significant weight loss or trim loss differences between the two dry aging methods.

Sensory analysis was conducted for the aerobic and anaerobic dry aging methods. The panelists found no difference between the two samples ($P < .05$, Table 2). This may have occurred through sampling of lean only. Much of the oxidation during aerobic dry aging occurs within the subcutaneous fat.

Results from the TBARS assay showed that there was a significant difference between the anaerobic and aerobic dry aged treatments as shown in Figure 2. Anaerobic samples had a level of oxidation similar to that of wet aged samples. Aerobic dry aging oxidation levels were nearly double the levels of both wet and anaerobically dry aged samples.

Further research via trained panelists is being conducted to determine if the

differences in oxidation levels significantly affect flavor.

Acknowledgement

This project was funded in part by The Beef Checkoff.

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